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Quarterly Report

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Contract Number: DTPH56-05-T-0003

Prepared for: United States Department of Transportation
Pipeline and Hazardous Materials Safety Administration
Office of Pipeline Safety

Project Title: "Consolidated Research and Development Program to Assess the Structural Significance of Pipeline Corrosion"

Prepared by: Mr. Vinod Chauhan
Principal Investigator
Advantica, Inc.
Ashby Rd.
Loughborough, LE11 3GR, England
vinod.chauhan@advanticagroup.com

Mr. Ian Wood
Team Project Manager
Electricore, Inc.
27943 Smyth Drive, Suite 105
Valencia, CA 91355
ian@electricore.org

Ms. Marina Smith
Team Technical Coordinator
Pipeline Research Council International, Inc.
1401 Wilson Blvd, Suite 1101
Arlington, VA 22209
msmith@prci.org

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Progress to Date

Three dimensional finite element (FE) models have been generated for a select number of pipe *D/t* ratios. Transmission pipe diameters (36-inch and 48-inch) and material grades X65, X80 and X100 (equivalent) have been selected to investigate the sensitivity of failure pressure on *D/t* ratio and material grade. To further validate models, investigate the damage tolerance of X100 material and enhance results obtained to date, Advantica has obtained permission to use the results of a test program undertaken on behalf of BP Exploration. This program was performed by Advantica under separate funding for BP Exploration, and focuses on investigating the corrosion damage tolerance of 52-inch diameter X100 pipe. Fourteen three-dimensional, non-linear FE models have been generated to predict failure pressures for 52-inch diameter grade X100 pipe with simulated corrosion defects. Patch, groove and slit like defects of depths up to 80% of the wall were modeled. Failure in the FE simulations was predicted using a criterion validated for material grades up to grade X65. It is concluded that this failure criterion is still valid for material grades up to X100. A comparison of test failure pressures with equation based assessment methods such as ASME B31G and RSTRENG have also been conducted. The following has been concluded from this work:

1 The ASME B31G and RSTRENG methods can give non-conservative failure predictions when assessing the remaining strength of higher strength (grade X80 and X100) corroded pipelines. Non-conservative failure predictions are generally observed for deeper defects (approaching 80% deep) using these methods. A similar result is produced for lower strength steels using these methods.
2 The LPC-1 method is the most accurate method for assessing the remaining strength of corroded higher strength (up to X100) pipelines. However, LPC-1 can give non-conservative failure predictions.
3 The non-linear FE method used to predict the failure pressure is valid for higher strength steels up to grade X100.
4 The LPC-1 method, with the flow stress modified to equal the average of the specified minimum yield and ultimate tensile strength, predicts conservative failure pressures for corroded pipelines of grades up to X100.The results of this work have been issued to DOT and PRCI for review.

A draft report describing the results has been issued to DOT and PRCI (Advantica Report 9017).

Work to progress the design of corrosion defects for the BP operational trial was also undertaken in this quarter. A draft report summarizing the work will be issued to the DOT shortly (Advantica Report 9245 Issue 2). This report details the methods used to design volumetric corrosion defects for the trial and includes both the design for static failure and for cyclic pressure loading. Defect dimensions have been calculated and drawings have been produced for manufacture. Details of defect dimensions chosen are described in Advantica Report 9245 Issue 2). Machining of the defects has been completed. Strain gauge channels have been allocated and gauge positions determined. Figure 1 shows photographs taken during the pipeline construction. Figure 2 shows a photograph of volumetric corrosion defects (patch and groove defects) machined on the external surface of the pipe.

Payable Milestones

The following payable milestones were completed during this reporting period:

- Design/Machine Corrosion Defects for Field (Operational) Trial
- Seventh Quarterly Status Report Submitted